CLAIMS

What is claimed is:

1.   1.   A method of programming a programmable logic controller, said programmable logic
2.   controller including a plurality of inputs and a plurality of outputs, said programmable logic
3.   controller directing a process through output signals at said outputs in response to input
4.   signals at said inputs, comprising the steps of:
5.   displaying to a user on a monitor a graphical data entry user interface for a plurality
6.   of sequential steps, said graphical data entry user interface representing respective inputs to
7.   be monitored by said programmable logic controller at each of said sequential steps and
8.   respective outputs to be initiated by said programmable logic controller at respective ones
9.   of said sequential steps;
10.   receiving, via said graphical data entry user interface, an identification of at least one
11.   input selected by said user to be monitored for at least one of said sequential steps and an
12.   identification of at least one output selected by said user to be initiated for said at least one
13.   of said sequential steps;
14.   converting said identification of said at least one input selected by said user into an
15.   input control data table, said input control data table including a plurality of input control
16.   data elements, each of said input control data elements corresponding to a respective one of
17.   said plurality of sequential steps, a respective one of said input control data elements
18.   representing said at least one input selected by said user; and
19.   converting said identification of said at least one output selected by said user into an
20.   output data table, said output data table including a plurality of output data elements, each
21.   of said output data elements corresponding to a respective one of said plurality of sequential
22.   steps, a respective one of said output data elements representing said at least one output
23.   selected by said user.

1.   2.   The method of claim 1, wherein said graphical data entry user interface includes a
2.   timer enable command option for each of said plurality of sequential steps and a timer value

3   option for each of said plurality of sequential steps.

1   3.   The method of claim 2, further comprising the steps of:

2   receiving, via said graphical data entry user interface, a selection by said user of a

3   timer enable command for at least one of said plurality of sequential steps;

4   receiving, via said graphical data entry user interface, a selection by said user of a

5   timer value for said one of said plurality of sequential steps; and

6   creating a timer value data table including at least one timer value data element, said

7   timer value data element representing said timer value,

8   wherein a respective one of said input control data elements represents said timer

9   enable command for said one of said sequential steps.

1   4.   The method of claim 3, wherein said input control data element includes a plurality

         of bits, a subset of said plurality of bits representing individual inputs of said programmable

         logic controller and at least a remaining one of said plurality of bits representing said timer

         enable command.

1   5.   The method of claim 1, wherein said input control data element includes a plurality

2   of bits and a subset of said plurality of bits represents individual inputs of said programmable

3   logic controller.

1   6.   The method of claim 1, wherein said graphical data entry user interface is a check

2   grid.

1   7.   The method of claim 1, further comprising the step of downloading said input control

2   data table and said output data table to said programmable logic controller.

1   8.   The method of claim 1, wherein said output data element includes a plurality of bits

2 and a subset of said plurality of bits represents individual outputs of said programmable logic

3 controller.

1 9. An apparatus for programming a programmable logic controller, said programmable

2 logic controller including a plurality of inputs and a plurality of outputs, said programmable

3 logic controller directing a process through output signals at said outputs in response to input

4 signals at said inputs, comprising:

5 means for displaying to a user on a monitor a graphical data entry user interface for

6 a plurality of sequential steps, said graphical data entry user interface representing respective

7 inputs to be monitored by said programmable logic controller at each of said sequential steps

8 and respective outputs to be initiated by said programmable logic controller at respective

9 ones of said sequential steps;

10 means for receiving, via said graphical data entry user interface, an identification of

11 at least one input selected by said user to be monitored for at least one of said sequential

12 steps and an identification of at least one output selected by said user to be initiated for said

13 at least one of said sequential steps;

14 means for converting said identification of said at least one input selected by said user

15 into an input control data table, said input control data table including a plurality of input

16 control data elements, each of said input control data elements corresponding to a respective

17 one of said plurality of sequential steps, a respective one of said input control data elements

18 representing said at least one input selected by said user; and

19 means for converting said identification of said at least one output selected by said

20 user into an output data table, said output data table including a plurality of output data

21 elements, each of said output data elements corresponding to a respective one of said

22 plurality of sequential steps, a respective one of said output data elements representing said

23 at least one output selected by said user.

1 10. The apparatus of claim 9, wherein said graphical data entry user interface includes

2   a timer enable command option for each of said plurality of sequential steps and a timer

3   value option for each of said plurality of sequential steps.

1   11.   The apparatus of claim 10, further comprising:

2   means for receiving, via said graphical data entry user interface, a selection by said

3   user of a timer enable command for at least one of said plurality of sequential steps;

4   means for receiving, via said graphical data entry user interface, a selection by said

5   user of a timer value for said one of said plurality of sequential steps; and

6   means for creating a timer value data table including at least one timer value data

7   element, said timer value data element representing said timer value,

8   wherein a respective one of said input control data elements represents said timer

9   enable command for said one of said sequential steps.

1   12.   The apparatus of claim 11, wherein said input control data element includes a

2   plurality of bits, a subset of said plurality of bits representing individual inputs of said

3   programmable logic controller and at least a remaining one of said plurality of bits

4   representing said timer enable command.

1   13.   The apparatus of claim 9, wherein said input control data element includes a plurality

2   of bits and a subset of said plurality of bits represents individual inputs of said programmable

3   logic controller.

1   14.   The apparatus of claim 9, wherein said graphical data entry user interface is a check

2   grid displayed on said monitor.

1   15.   The apparatus of claim 9, further comprising means for downloading said input

2   control data table and said output data table to said programmable logic controller.

1   16.   The apparatus of claim 9, wherein said output data element includes a plurality of bits

2   and a subset of said plurality of bits represents individual outputs of said programmable logic

3   controller.

1   17.   A computer-readable medium encoded with a computer program code for

2   programming a programmable logic controller, said programmable logic controller including

3   a plurality of inputs and a plurality of outputs, said programmable logic controller directing

4   a process through output signals at said outputs in response to input signals at said inputs,

5   the medium comprising:

6   a first code segment for displaying to a user on a monitor a graphical data entry user

7   interface for a plurality of sequential steps, said graphical data entry user interface

8   representing respective inputs to be monitored by said programmable logic controller at each

9   of said sequential steps and respective outputs to be initiated by said programmable logic

10   controller at respective ones of said sequential steps;

11   a second code segment for receiving, via said graphical data entry user interface, an

12   identification of at least one input selected by said user to be monitored for at least one of

13   said sequential steps and an identification of at least one output selected by said user to be

14   initiated for said at least one of said sequential steps;

15   a third code segment for converting said identification of said at least one input

16   selected by said user into an input control data table, said input control data table including

17   a plurality of input control data elements, each of said input control data elements

18   corresponding to a respective one of said plurality of sequential steps, a respective one of

19   said input control data elements representing said at least one input selected by said user; and

20   a fourth code segment for converting said identification of said at least one output

21   selected by said user into an output data table, said output data table including a plurality of

22   output data elements, each of said output data elements corresponding to a respective one of

23   said plurality of sequential steps, a respective one of said output data elements representing

24   said at least one output selected by said user.

1   18.   The computer-readable medium of claim 17, wherein said graphical data entry user

2   interface includes a timer enable command option for each of said plurality of sequential

3   steps and a timer value option for each of said plurality sequential steps.

1   19.   The computer-readable medium of claim 18, further comprising:

2   a fifth code segment for receiving, via said graphical data entry user interface, a

3   selection by said user of a timer enable command for at least one of said plurality of

4   sequential steps;

5   a sixth code segment for receiving, via said graphical data entry user interface, a

6   selection by said user of a timer value for said one of said plurality of sequential steps; and

7   a seventh code segment for creating a timer value data table including at least one

8   timer value data element, said timer value data element representing said timer value,

9   wherein a respective one of said input control data elements represents said timer

10   enable command for said one of said sequential steps.

20.   A computer data signal embodied in a carrier wave encoded with computer program

code for programming a programmable logic controller, said programmable logic controller

including a plurality of inputs and a plurality of outputs, said programmable logic controller

4   directing a process through output signals at said outputs in response to input signals at said

5   inputs, comprising:

6   a first code segment for displaying to a user on a monitor a graphical data entry user

7   interface for a plurality of sequential steps, said graphical data entry user interface

8   representing respective inputs to be monitored by said programmable logic controller at each

9   of said sequential steps and respective outputs to be initiated by said programmable logic

10   controller at respective ones of said sequential steps;

11   a second code segment for receiving, via said graphical data entry user interface, an

12   identification of at least one input selected by said user to be monitored for at least one of

13   said sequential steps and an identification of at least one output selected by said user to be

14   initiated for said at least one of said sequential steps;

15   a third code segment for converting said identification of said at least one input

16   selected by said user into an input control data table, said input control data table including

17   a plurality of input control data elements, each of said input control data elements

18   corresponding to a respective one of said plurality of sequential steps, a respective one of

19   said input control data elements representing said at least one input selected by said user; and

20   a fourth code segment for converting said identification of said at least one output

21   selected by said user into an output data table, said output data table including a plurality of

22   output data elements, each of said output data elements corresponding to a respective one of

23   said plurality of sequential steps, a respective one of said output data elements representing

24   said at least one output selected by said user.

21.   The computer data signal of claim 20, wherein said graphical data entry user interface

includes a timer enable command option for each of said plurality of sequential steps and a

timer value option for each of said sequential steps.

22.   The computer data signal of claim 21, further comprising:

a fifth code segment for receiving, via said graphical data entry user interface, a

selection by said user of a timer enable command for at least one of said plurality of

sequential steps;

a sixth code segment for receiving, via said graphical data entry user interface, a

selection by said user of a timer value for said one of said plurality of sequential steps; and

a seventh code segment for creating a timer value data table including at least one

timer value data element, said timer value data element representing said timer value,

wherein a respective one of said input control data elements represents said timer

enable command for said one of said sequential steps.

1   23.   A method of controlling a process with a programmable logic controller, said

2   programmable logic controller including a plurality of inputs and a plurality of outputs, said

3   programmable logic controller directing said process through signals at said outputs in

4   response to input signals at said inputs, comprising the steps of:

5   accessing with said programmable logic controller an input control data element for

6   a sequential step and an output data element for said sequential step from an input control

7   data table and an output data table, respectively, said input control data table including input

8   control data elements for a plurality of sequential steps that include said sequential step and

9   said output data table including a plurality of output data elements for said plurality of

10   sequential steps;

11   providing output signals at outputs of said programmable logic controller identified

12   by said output data element to be activated for said sequential step;

13   monitoring inputs identified by said input control data element to be monitored for

14   said sequential step; and

15   performing a next one of said plurality of sequential steps if an input signal is

16   detected for at least one of said monitored inputs.

     24.   The method of claim 23, wherein at least one input control data element represents

2   a timer enable command for a respective one of said plurality of sequential steps, said

3   method further comprising the steps of:

4   accessing with said programmable logic controller a timer value from a timer value

5   data table for said sequential step;

6   enabling a timer for a time period indicated by said timer value for said sequential

7   step; and

8   performing a next sequential step when said time period expires.

1   25.   The method of claim 24, wherein said input control data element includes a plurality

2   of bits and a subset of said plurality of bits represents individual inputs of said programmable

3   logic controller and at least one of said subset of bits represents said timer enable command.

1   26.   The method of claim 23, wherein said input control data element includes a plurality

2   of bits and a subset of said plurality of bits represents individual inputs of said programmable

3   logic controller.

1   27.   The method of claim 23, wherein said input control data element and said output data

2   element are accessed from a local storage medium.

1   28.   The method of claim 23, wherein said output data element includes a plurality of bits

2   and a subset of said plurality of bits represents individual outputs of said programmable logic

3   controller.

1   29.   The method of claim 23, further comprising the steps of:

2   creating said input control data table; and

3   creating said output data table.

1   30.   The method of claim 29, wherein said steps of creating said input control data table

2   and said output data table include the following steps:

3   displaying to a user on a monitor a graphical data entry user interface for a plurality

4   of sequential steps, said graphical data entry user interface representing respective inputs to

5   be monitored by said programmable logic controller at each of said sequential steps and

6   respective outputs to be initiated by said programmable logic controller at respective ones

7   of said sequential steps;

8   receiving, via said graphical data entry user interface, an identification of at least one

9   input selected by said user to be monitored for at least one of said sequential steps and an

10   identification of at least one output selected by said user to be initiated for said at least one

11   of said sequential steps;

12   converting said identification of said at least one input selected by said user into said

13   input control data table; and

14   converting said identification of said at least one output selected by said user into said

15   output data table.

1   31.   The method of claim 30, wherein said graphical data entry user interface includes a

2   timer enable command option for each of said plurality of sequential steps and a timer value

3   option for each of said plurality of sequential steps.

1   32.   The method of claim 31, further comprising the steps of:

2   receiving, via said graphical data entry user interface, a selection by said user of a

3   timer enable command for at least one of said plurality of sequential steps;

4   receiving, via said graphical data entry user interface, a selection by said user of a

5   timer value for said one of said plurality of sequential steps; and

6   creating a timer value data table including at least one timer value data element, said

7   timer value data element representing said timer value.

1   33.   The method of claims 32, wherein at least one input control data element represents

2   a timer enable command for a respective one of said plurality of sequential steps, said

3   method further comprising the steps of:

4   accessing with said programmable logic controller a timer value from a timer value

5   data table for said sequential step;

6   enabling a timer for a time period indicated by said timer value for said sequential

7   step; and

8   performing a next sequential step when said time period expires.

1   34.   A programmable logic controller for controlling a process, said programmable logic

2   controller comprising:

3   a plurality of inputs and a plurality of outputs, said programmable logic controller

4   directing said process via signals provided at said outputs in response to input signals at said

5   inputs;

6   means for accessing an input control data element for a sequential step and an output

7   data element for said sequential step from an input control data table and an output data

8   table, respectively, said input control data table including input control data elements for a

9   plurality of sequential steps that include said sequential step and said output data table

10   including a plurality of output data elements for said plurality of sequential steps;

11   means for providing output signals at outputs of said programmable logic controller

12   identified by said output data element to be activated for said sequential step;

13   means for monitoring inputs identified by said input control data element to be

14   monitored for said sequential step; and

15   means for performing a next one of said plurality of sequential steps if an input signal

16   is detected for at least one of said monitored inputs.

35.   The programmable logic controller of claim 34, wherein at least one input control

data element represents a timer enable command for a respective one of said plurality of

sequential steps, said programmable logic controller further comprising:

4   means for accessing a timer value from a timer value data table for said sequential

5   step;

6   means for enabling a timer for a time period indicated by said timer value for said

7   sequential step; and

8   means for performing a next sequential step when said time period expires.

1   36.   The programmable logic controller of claim 35, wherein said input control data

2   element includes a plurality of bits and a subset of said plurality of bits represents individual

3   inputs of said programmable logic controller and at least one of said subset of bits represents

4   said timer enable command.

1   37.   The programmable logic controller of claim 34, wherein said input control data

2   element includes a plurality of bits and a subset of said plurality of bits represents individual

3   inputs of said programmable logic controller.

1   38.   The programmable logic controller of claim 34, wherein said input control data

2   element and said output data element are accessed from a local storage medium.

1   39.   The programmable logic controller of claim 34, wherein said output data element

2   includes a plurality of bits and a subset of said plurality of bits represents individual outputs

3   of said programmable logic controller.

    40.   The programmable logic controller of claim 34, further comprising:

            means for creating said input control data table; and

            means for creating said output data table.

    41.   The programmable logic controller of claim 40, wherein said means for creating said

    input control data table and said output data table include the following:

            means for displaying to a user on a monitor a graphical data entry user interface for

4   a plurality of sequential steps, said graphical data entry user interface representing respective

5   inputs to be monitored by said programmable logic controller at each of said sequential steps

6   and respective outputs to be initiated by said programmable logic controller at respective

7   ones of said sequential steps;

8   means for receiving, via said graphical data entry user interface, an identification of

9   at least one input selected by said user to be monitored for at least one of said sequential

10 steps and an identification of at least one output selected by said user to be initiated for said

11 at least one of said sequential steps;

12   means for converting said identification of said at least one input selected by said user

13   into said input control data table; and

14   means for converting said identification of said at least one output selected by said

15   user into said output data table.

1   42.   The programmable logic controller of claim 41, wherein said graphical data entry user

2   interface includes a timer enable command option for each of said plurality of sequential

3   steps and a timer value option for each of said plurality of sequential steps.

1   43.   The programmable logic controller of claim 42, further comprising:

2   means for receiving, via said graphical data entry user interface, a selection by said

3   user of a timer enable command for at least one of said plurality of sequential steps;

4   means for receiving, via said graphical data entry user interface, a selection by said

5   user of a timer value for said one of said plurality of sequential steps; and

6   means for creating a timer value data table including at least one timer value data

7   element, said timer value data element representing said timer value.

      44.   The programmable logic controller of claims 43, wherein at least one input control

      data element represents a timer enable command for a respective one of said plurality of

3   sequential steps, further comprising:

4   means for accessing with said programmable logic controller a timer value from a

5   timer value data table for said sequential step;

6   means for enabling a timer for a time period indicated by said timer value for said

7   sequential step; and

8   means for performing a next sequential step when said time period expires.

1   45.   A computer-readable medium encoded with a computer program code for controlling

2   a process with a programmable logic controller, said programmable logic controller including

3   a plurality of inputs and a plurality of outputs, said programmable logic controller directing

4   said process through signals at said outputs in response to input signals at said inputs, the

5   medium comprising:

6   a first code segment that causes said programmable logic controller to access an input

7   control data element for a sequential step and an output data element for said sequential step

8   from an input control data table and an output data table, respectively, said input control data

9   table including input control data elements for a plurality of sequential steps that include said

10   sequential step and said output data table including a plurality of output data elements for

11   said plurality of sequential steps;

12   a second code segment that causes said programmable logic controller to provide

13   output signals at outputs of said programmable logic controller identified by said output data

14   element to be activated for said sequential step;

15   a third code segment that causes said programmable logic controller to monitor inputs

16   identified by said input control data element to be monitored for said sequential step; and

17   a fourth code segment that causes said programmable logic controller to perform a

18   next one of said plurality of sequential steps if an input signal is detected for at least one of

19   said monitored inputs.

1   46.   The computer-readable medium of claim 45, wherein at least one input control data

2   element represents a timer enable command for a respective one of said plurality of

3   sequential steps, said computer-readable medium further comprising:

4   a fifth code segment that causes said programmable logic controller to access a timer

5   value from a timer value data table for said sequential step;

6   a sixth code segment that causes said programmable logic controller to enable a timer

7   for a time period indicated by said timer value for said sequential step; and

8   a seventh code segment that causes said programmable logic controller to perform

9   a next sequential step when said time period expires.

1   47.   A computer data signal embodied in a carrier wave encoded with computer program

2   code for controlling a process with a programmable logic controller, said programmable

3   logic controller including a plurality of inputs and a plurality of outputs, said programmable

4   logic controller directing a process through output signals at said outputs in response to input

5   signals at said inputs, said computer data signal comprising:

6   a first code segment that causes said programmable logic controller to access an input

7   control data element for a sequential step and an output data element for said sequential step

8   from an input control data table and an output data table, respectively, said input control data

9   table including input control data elements for a plurality of sequential steps that include said

10   sequential step and said output data table including a plurality of output data elements for

11   said plurality of sequential steps;

12   a second code segment that causes said programmable logic controller to provide

13   output signals at outputs of said programmable logic controller identified by said output data

14   element to be activated for said sequential step;

15   a third code segment that causes said programmable logic controller to monitor inputs

16   identified by said input control data element to be monitored for said sequential step; and

17   a fourth code segment that causes said programmable logic controller to perform a

18   next one of said plurality of sequential steps if an input signal is detected for at least one of

19   said monitored inputs.

1   48.   The computer data signal of claim 47, wherein at least one input control data element

2   represents a timer enable command for a respective one of said plurality of sequential steps,

3   said computer data signal further comprising:

4   a fifth code segment that causes said programmable logic controller to access a timer

5   value from a timer value data table for said sequential step;

6   a sixth code segment that causes said programmable logic controller to enable a timer

7   for a time period indicated by said timer value for said sequential step; and

8   a seventh code segment that causes said programmable logic controller to perform

9   a next sequential step when said time period expires.